# APPENDIX C
# UNPAVED ROAD SEDIMENT ASSESSMENT

## Yaak River TMDL Planning Area

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# 1.0 INTRODUCTION

This report presents a sediment and culvert assessment of the unpaved road network within the Yaak River TMDL Planning Area (TPA). This assessment was performed as part of the development of sediment TMDLs for 303(d) Listed stream segments with sediment as a documented impairment.

Objectives of the assessment include:

- Estimate existing annual sediment loads to streams derived from road crossings and contributing (parallel) road segments in the Yaak TPA, specifically in impaired watersheds, Seventeenmile Creek, Lap Creek, and South Fork Yaak River.
- Estimate potential maximum annual sediment loading to streams from culvert failure in the Yaak TPA, specifically in impaired watersheds, Seventeenmile Creek, Lap Creek, and South Fork Yaak River.
- Estimate potential sediment loading reductions from roads and culverts in watersheds, Seventeenmile Creek, Lap Creek, and South Fork Yaak River.
- Assess fish passage capabilities at selected culvert locations within Seventeenmile Creek, Lap Creek, and South Fork Yaak River.

Roads located near stream channels can impact stream function through degradation of riparian vegetation, channel encroachment, and sediment loading. The degree of sediment loading is determined by a number of factors including road type, construction specifications, drainage, soil type, topography, and precipitation. Using a combination of GIS analysis, field assessment, and modeling, estimated sediment loads were developed for both road crossings and parallel road segments using the ***WEPP:Road*** model. Existing sediment loads from roads were estimated, as were as potential sediment load reductions. Existing culverts were also assessed for fish passage and failure potential using culvert data collected by the Yaak Valley Forest Council (YVFC) in 2004 – 2006.

The Yaak TPA (USGS HUC ID #17010103) is located in the remote northwest corner of Montana in Lincoln County. The Yaak watershed extends into Canada along the northern Montana border, and drains to the Kootenai River six miles downstream of the town of Troy. The 2006 303(d) List identifies three stream segments as impaired for sediment: Seventeenmile Creek, Lap Creek, and South Fork Yaak River. This road assessment addresses road sediment load estimations and reductions for Lap Creek, Seventeenmile Creek, and the South Fork Yaak River.

# 2.0 DATA COLLECTION

The Yaak Road Sediment assessment consisted of three primary tasks:

1. Selection of modeling approach and development of a Sampling and Analysis Plan (SAP)
2. Field assessments of road networks and culverts
3. Modeling of sediment loads and reduction potential

Additional information on assessment techniques is available in prior reporting for this project: *Road GIS Layers and Summary Statistics* (MDEQ 2007), and *Yaak Roads Assessment: Sampling and Analysis Plan* (MDEQ 2007).

## 2.1 Spatial Analysis

Using road layers provided by the Kootenai National Forest (KNF), road crossings and parallel segments in the road network were identified and classified by road type (**Table C-1**) relative to 7$^{th}$ code subwatershed.

**Table C-1. Kootenai National Forest Road Type Classifications**

| IGBC Code | KNF Road Classification |
|---|---|
| 1 | Impassible to Motorized Vehicles |
| 2 | Restricted/Legally Gated Admin Use |
| 3 | Barriered/Legally No Admin Use |
| 4 | Open for Public Use |

Crossings statistics were developed based on 7$^{th}$ code subwatershed for the three sediment listed watersheds to be addressed in this road assessment: there are 23 unpaved road crossings in the Lap Creek watershed, 108 unpaved crossings in the Seventeenmile watershed, and 123 unpaved crossings in the South Fork of the Yaak watershed (**Attachment A—Table C-13**). Field assessment work focused on the unpaved road crossings in these three watersheds: no roads were assessed outside of Seventeenmile Creek, Lap Creek, or South Fork Yaak River watersheds.

Over the past 15 years, many roads in the Yaak TPA have been closed and/or have had travel restrictions placed on them in order to preserve grizzly bear habitat. Roads within Grizzly Bear Core Management Area (Core) designation are closed to all motorized traffic, while other roads are closed to public use and are used minimally for administrative use only. These closures and travel restrictions have resulted in drastically different conditions on closed vs. open roads. Closed roads typically have vegetative growth over most if not all of the road surface, and in many instances woody vegetation dominates the (previous) travel corridor. Sediment production and delivery from these roads is substantially lower than that observed on open roads.

A random subset of unpaved crossing sites was generated for field assessment based on the proportion of total unpaved crossings within the Lap Creek, Seventeenmile Creek (upper and lower), and South Fork of the Yaak River watersheds with approximately 20% of the crossings assessed (52 sites). Parallel road segments were identified as areas where roads encroach upon the stream channel, and total road lengths within 50-foot and 100-foot buffer zones were generated.

## 2.2 Field Data Collection

A total of 49 unpaved crossings and 2 unpaved parallel segments were randomly selected for field evaluation. Twenty six (26) crossings were assessed in the South Fork of the Yaak River (21% of total), twenty one (21) were assessed in Seventeenmile Creek (19% of total), and two were assessed in Lap Creek (9% total). Due to limited field time and budget, some adjustments of the random GIS crossing selection were made, as many of these sites required significant hiking to reach. A lower percentage of crossings were assessed in Lap Creek due to the fact that 22 of 23 crossings were in Core management areas requiring substantial effort and time to reach. An assumption was made that all crossings within Lap Creek Core areas are similar in condition to the assessed sites. Two crossings in the South Fork of Yaak had been decommissioned (culverts pulled and road grades obliterated) and were removed from the loading analysis.

In the field, parallel road segments were selected based on best professional judgment while traveling roads on which specific crossings were selected for evaluation. Parallel segments were selected in a manner where road segments would not be duplicated in both the crossing and parallel sediment load calculations. Two parallel segments were assessed in the Yaak TPA, one in the South Fork of the Yaak River and one in Upper Seventeenmile Creek. Based on field reconnaissance, it was determined in the field that parallel road segments were not a significant source of sediment loading unless the stream buffer was very small (less than 20 feet) due to the extremely dense forest vegetation and stream buffers. Extensive travel within Seventeenmile Creek and the South Fork Yaak River watersheds confirmed the non-significance of parallel segment contributions. As a result, parallel segments were only assessed if located very near a stream and if evidence of sediment delivery was noted. One parallel segment representative of the dense vegetation conditions and low sediment delivery was measured (SFY-4A-P), as well as one segment where the road was located very near the stream and delivery was high, relatively (USC-2A-P). Field data spreadsheets with detailed information on each road crossing and parallel segment are included in **Attachment B**.

## 2.3 Sediment Assessment Methodology

The road sediment assessment was conducted using the ***WEPP:Road*** forest road erosion prediction model (http://forest.moscowfsl.wsu.edu/fswepp/). WEPP:Road is an interface to the Water Erosion Prediction Project (WEPP) model (Flanagan and Livingston, 1995), developed by the USDA Forest Service and other agencies, and is used to predict runoff, erosion, and sediment delivery from forest roads. The model predicts sediment yields based on specific soil, climate, ground cover, and topographic conditions. Specifically, the following model input data was collected in the field: soil type, percent rock, road surface, road design, traffic level, and specific road topographic values (road grade, road length, road width, fill grade, fill length, buffer grade, and buffer length). In addition, supplemental data was collected on vegetation condition of the buffer, evidence of erosion from the road system, and potential for culvert failure.

Site specific climate profiles were created using data from the Western Regional Climate Center (http://www.wrcc.dri.edu). Due to the lack of available long-term precipitation stations in the Yaak TPA, one station from outside the planning area was selected to model the higher elevation sites (>3,500 feet). The selected station, Burke 2 ENE, Idaho (101272), contained similar climate and elevation conditions as those encountered in the Yaak (48.9 inches annual precipitation; 4090 feet elevation). The Troy 18N, Montana (248395), station was used to model the lower elevation sites below 3,500 feet in elevation (35.60 inches annual precipitation; 2720 feet elevation). Thirty year simulations were run for each unpaved road crossing segment.

Field assessment revealed that a large number of roads within Core management areas and roads with administrative or barriers to limit access were completely vegetated and contained significant downfall and understory on the road prism. The WEPP:Road model did not account for these road vegetation conditions; as a result, some adjustments were made to the model to more appropriately represent these types of roads. **Attachment C** contains a description of model adjustments, as recommended by the model author (Elliot, pers comm).

## 2.4 Mean Sediment Loads from Field Assessed Sites

Field assessment data and WEPP:Road modeling results were used to develop sediment loads based on various watershed criteria. A standard statistical breakdown of loads from the unpaved road network within each sediment-listed watershed was generated using an applicable dataset of field assessed sites. Mean load and contributing length, median load, maximum and minimum loads, and 25$^{th}$ and 75$^{th}$ percentile loads were calculated for unpaved road crossings within the three 6$^{th}$ code subwatersheds that were the basis of the field assessment. Mean sediment loads from unpaved road crossings were estimated at 0.18 tons/year in the South Fork of the Yaak River watershed, 0.40 tons/year in the Seventeenmile Creek watershed (0.47 tons/year – Upper, 0.27 tons/year-Lower), and 0.01 tons/year in the Lap Creek watershed. A statistical summary of sediment loads for field assessed sites are included in **Table C-2**.

**Table C-2. Sediment Load Summary for Field Assessed Sites by Listed Watershed**

| Statistical Parameter | South Fork Yaak River | Lower Seventeenmile Creek | Upper Seventeenmile Creek | Lap Creek | Total of Field Assessed Crossings |
|---|---|---|---|---|---|
| Number of Sites (n) | 24 | 7 | 14 | 2 | 47 |
| Mean Contributing Length (ft) | 290 | 316 | 365 | 300 | 317 |
| Mean Load (tons/year) | 0.18 | 0.27 | 0.47 | 0.01 | 0.27 |
| Median Load (tons/year) | 0.08 | 0.05 | 0.04 | 0.01 | 0.04 |
| Maximum Load (tons year) | 1.24 | 1.05 | 2.89 | 0.011 | 2.89 |
| Minimum Load (tons/year) | 0.0002 | 0.0006 | 0.0002 | 0.0003 | 0.0002 |
| 25th Percentile (tons/year) | 0.003 | 0.015 | 0.028 | N/A | 0.01 |
| 75th Percentile (tons/year) | 0.25 | 0.38 | 0.21 | N/A | 0.26 |

The sediment load summary shows large differences between minimum and maximum load values, as well as between mean and median values. These data suggest that a small number of high sediment load crossing sites impact the average values significantly. Mean sediment loads were calculated and classified based on KNF road types. Results are shown in **Table C-3**. Clearly, roads that have restricted use (IGBC classification 1, 2, and 3) have much lower sediment loading estimates than those that are open to public use (IGBC classification 4) due primarily to absence of motorized travel resulting in vegetative recovery on road surfaces.

**Table C-3. Mean Stream Crossing Sediment Loads by Road Type**

| KNF Road Classification (IGBC) | Number of Sites Assessed | Mean Contributing Length (ft) | Mean Sediment Load (tons/yr) |
|---|---|---|---|
| 1 – Impassible to Motorized Vehicles | 4 | 170 | 0.001 |
| 2 – Restricted/Legally Gated Admin Use | 15 | 268 | 0.06 |
| 3 – Barriered/Legally No Admin Use | 10 | 207 | 0.11 |
| 4 – Open for Public Use | 18 | 451 | 0.60 |

Two assessed crossing sites had been reclaimed by USFS with culverts removed and road grades obliterated (SFY-2B and 3B); as a result, these two crossings were not included in the road crossing loading analysis. Due to the small number of parallel road assessments observed and sampled in the field and the minimal impact noted, a mean parallel road segment load was not calculated. A summary of modeling results from field assessed sites is located in **Attachment B**.

# 3.0 UNPAVED ROAD NETWORK SEDIMENT ANALYSIS

Estimates of mean sediment loads from road crossings, parallel road segments and culvert failure were extrapolated to all sites within the Seventeenmile Creek, Lap Creek, and South Fork Yaak River watersheds.

## 3.1 Sediment Load from Road Crossings

Mean sediment loads from field assessed sites from each road type were used to extrapolate loads throughout the three impaired watersheds: Seventeenmile Creek, Lap Creek and South Fork Yaak River. Mean loads for unpaved crossings (**Table C-4**) were applied to the total number of crossings within these three watersheds at the 7$^{th}$ code HUC scale. The total modeled sediment load from unpaved crossings in Seventeenmile Creek, Lap Creek, and South Fork Yaak River watersheds is 23.7, 2.37, and 21.29 tons/year respectively. The majority of sediment load is generated from crossings on roads open to public use (IGBC code-4). Road crossing sediment loading estimates for sediment-impaired watersheds, Seventeenmile Creek, Lap Creek, and South Fork Yaak River at the HUC 7 scale are given in (**Attachment A—Tables C-14, C-15, and C-16**).

It should be noted that sediment loading estimates are based on extrapolated model results, and may not be accurate representations of actual sediment loading values. Sediment loading estimates are more appropriate as <u>relative</u> estimates and can provide resource managers with tools to allow for better prioritization and planning of restoration activities designed to reduce sediment loading.

## 3.2 Sediment Load from Parallel Road Segments

The two field-assessed parallel road segments in the Yaak TPA showed very different modeling results, with site SFY-4AP having a load of 0.02 tons/year and site USC-2AP having a load of 1.13 tons/year. Site SFY-4AP contained an average buffer distance of 70 feet and site USC-2AP had an average buffer distance of 10 feet. The majority of parallel sites observed in the field contained buffer distances greater than 50 feet and were heavily vegetated, with no evidence of sediment delivery to the stream. USC-2AP was the only parallel site where evidence of sediment loading was noted. **Figures C-1 and C-2** are included to show differences in the typical buffer conditions of the two parallel segments assessed.

**Figure C-1. Parallel Segment SFY-4A-P – Average Buffer Distance 70 feet**

**Figure C-2. Parallel Segment USC-2A-P – Average Buffer Distance 10 feet**

Field observations within Seventeenmile Creek and the South Fork Yaak River watersheds indicated that the vast majority of parallel road segments do not contribute significant sediment to streams, and buffer distances must be very small for impacts to occur. This conclusion was drawn based on observations in the three assessed subwatersheds only and the fact that nearly the entire road network within these areas was traveled during fieldwork; site USC-2A-P was the only site where evidence of delivery was noted. Also, a large portion of parallel road distance calculated in the GIS layers is present at road crossing locations and is accounted for in the crossing load calculations. As a result, parallel road segments are likely a minor contributor to overall sediment loading from the unpaved road network with isolated locations where roads are very close to streams. Due to the small buffer distance required to have a significant parallel impact, the use of GIS layers to identify these areas and extrapolate loads is not feasible since these layers are often not accurate to this level resolution.

## 3.3 Culvert Assessment

Culvert crossing assessment and analysis within the Yaak TPA was conducted in order to:

- Assess the ability of existing culverts to allow fish passage
- Estimate the potential for sediment loading to streams due to culvert failure

Data from a detailed culvert study conducted by the Yaak Valley Forest Council (YVFC) from 2004 - 2006 was used to complete the analysis, along with data collected during the road sediment field assessment in June 2007. Global positioning system data from sites assessed during the road sediment assessment were compared to those collected at YVFC sites. Using a snap feature in GIS, road assessment sites were linked to the closest YVFC site. Sites located within 200-feet of each other were considered to be the same location, due to variations in measurement and GPS accuracy. These sites were then checked against maps provided by the YVFC to determine accuracy. Crossing sites with bridges and decommissioned sites were removed from the dataset, as were sites that contained missing or incomplete data.

### 3.3.1 Fish Passage at Culverts

The fish passage assessment provided herein relies on culvert and crossing data collected in the field by the Yaak Valley Forest Council in the summers of 2004-2006. The assessment should be considered a coarse filter that identifies culverts as having probable fish passage issues and may be used as a starting point for prioritization of planning efforts designed to address culvert deficiencies within the Yaak TPA so that full support for aquatic life uses may be restored. It must be noted that this evaluation of fish passage through culverts aims to assess the capability of a culvert to allow juvenile fish passage and does not consider whether associated streams are fish-bearing or have fishery resource value; further analysis should be conducted in order to properly prioritize and plan implementation activities in order to meet restoration goals.

For the purposes of this assessment, a culvert is considered to be a blockage to fish passage if it fails to allow passage of juvenile fish species (typically salmonids). In evaluating the ability of existing culverts to allow for fish passage, a variety of obstacles to fish passage were considered: constriction ratio, culvert gradient, and culvert outlet vertical barriers (perch). In order to quickly assess the ability of existing culverts to allow for fish passage, evaluation criteria for the Yaak TPA were adopted from USDA Forest Service Region 1 fish passage criteria (**Figure C-3**). The evaluation criteria classify culverts by type and establish thresholds for:

- culvert gradient
- stream constriction

- outlet drop (perch)

Each culvert is placed into one of the three classifications based on whether criteria are met or not:

1. GREEN: conditions that have a high certainty of providing juvenile fish passage.
2. RED: conditions that have a high certainty of not providing juvenile fish passage.
3. GREY: conditions are such that additional and more detailed analysis is required to determine juvenile fish passage ability.

**Table C-4. USDA Forest Service Region 1 Juvenile Fish Passage Evaluation Criteria**

| Structure Type | GREEN | GREY | RED |
|---|---|---|---|
| Circular CMP ≤ 48" * w/Spiral Corrugations | Culvert gradient <0.5%<br>No perch<br>Constriction ratio >0.70 | Culvert gradient 0.5% to 1.0%<br>Perch < 4"<br>Constriction ratio 0.5 to 0.70 | Culvert gradient > 1.0%<br>Perch > 4"<br>Constriction ratio < 0.5 |

** the predominant culvert type in the Yaak TPA*

With the exception of mainstem segments of Seventeenmile Creek and South Fork Yaak River, most stream and culvert grades are greater than 1.0%, thereby placing nearly all culverts (97%) assessed in the red category based solely on culvert gradient. When the suite of criteria (culvert gradient, perch, constriction ratio) was considered, no culverts met the "green" classification.

Evaluation of individual criterion was conducted in order to assess the spatial distribution of culvert sites not meeting both individual criterion and the suite of criteria given in **Table C-4**. **Figure C-4** shows the percent of culverts within Seventeenmile Creek, Lap Creek, and the South Fork Yaak River that currently do not meet individual passage criterion. **Figures C-5 through C-7** display the distribution of this data throughout the three watersheds.

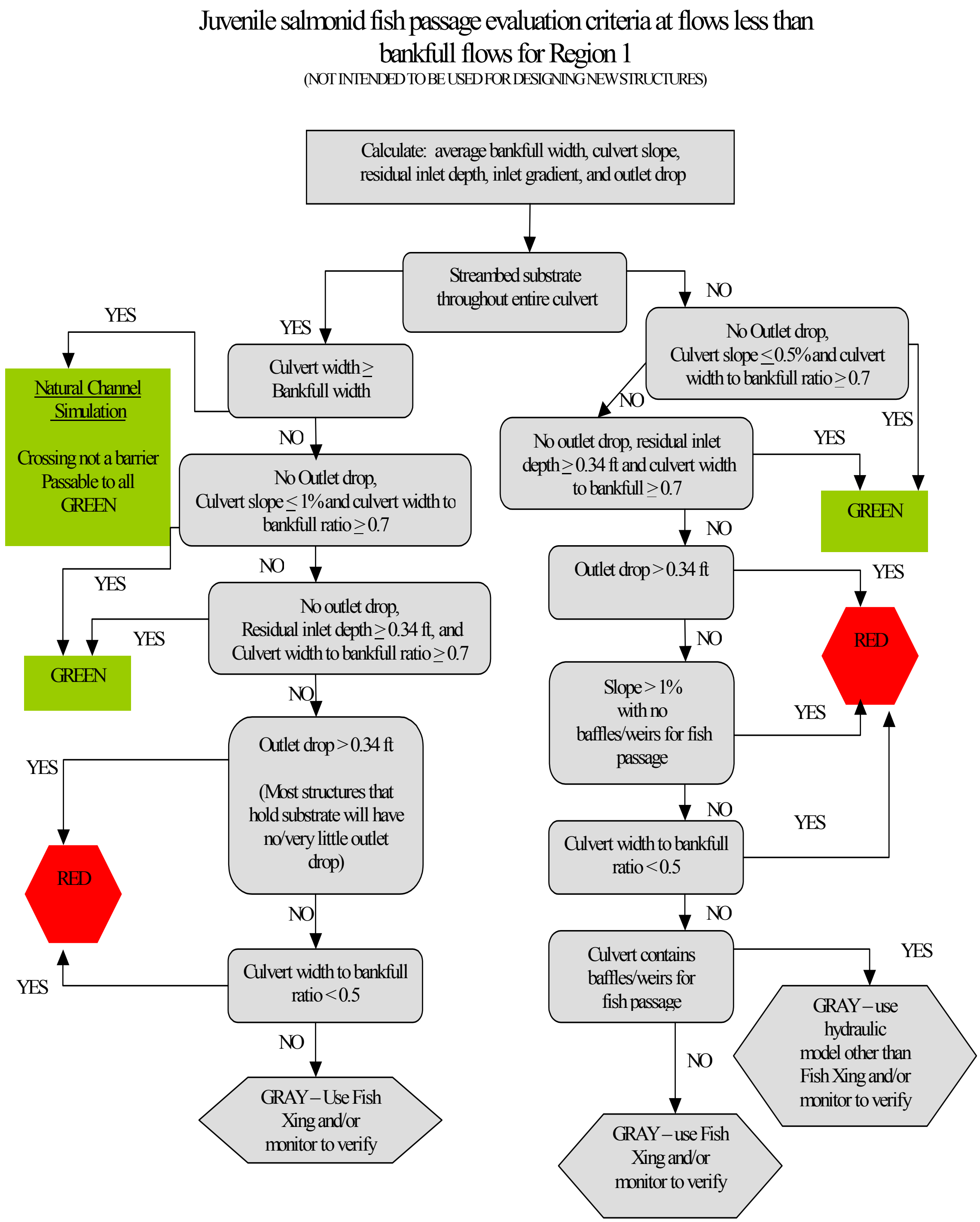


**Figure C-3. Northern Region Juvenile Salmonid Passage Screening Schematic**

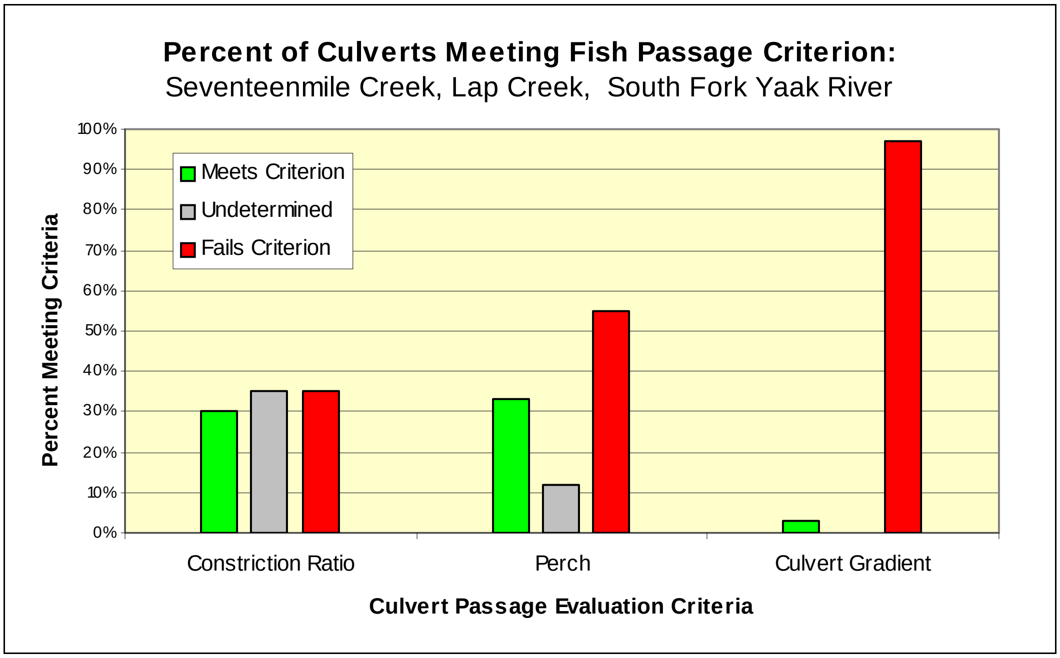


**Figure C-4. Percent of Culverts Meeting Fish Passage Criterion**

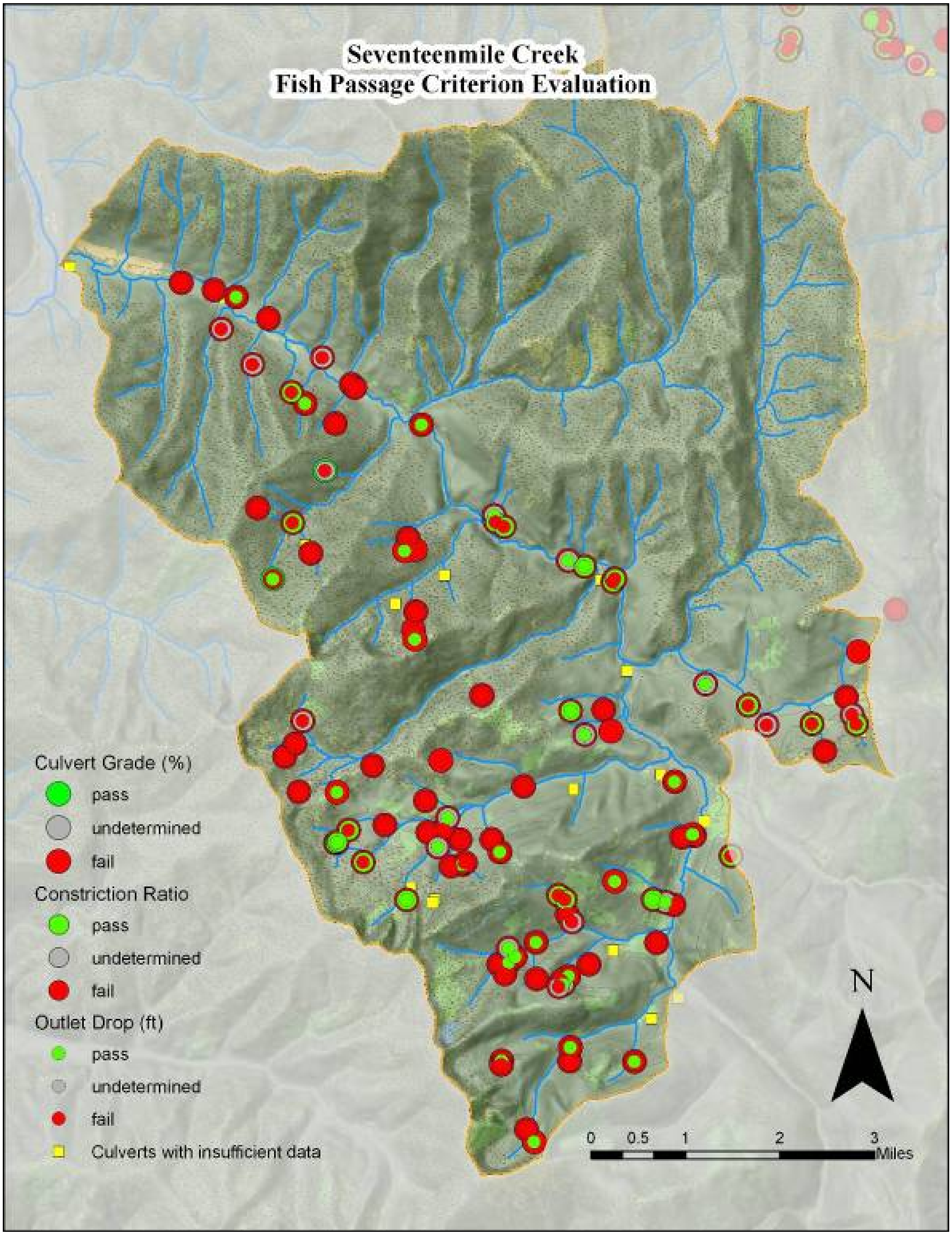


**Figure C-5. Seventeenmile Creek Fish Passage Criterion Evaluation**

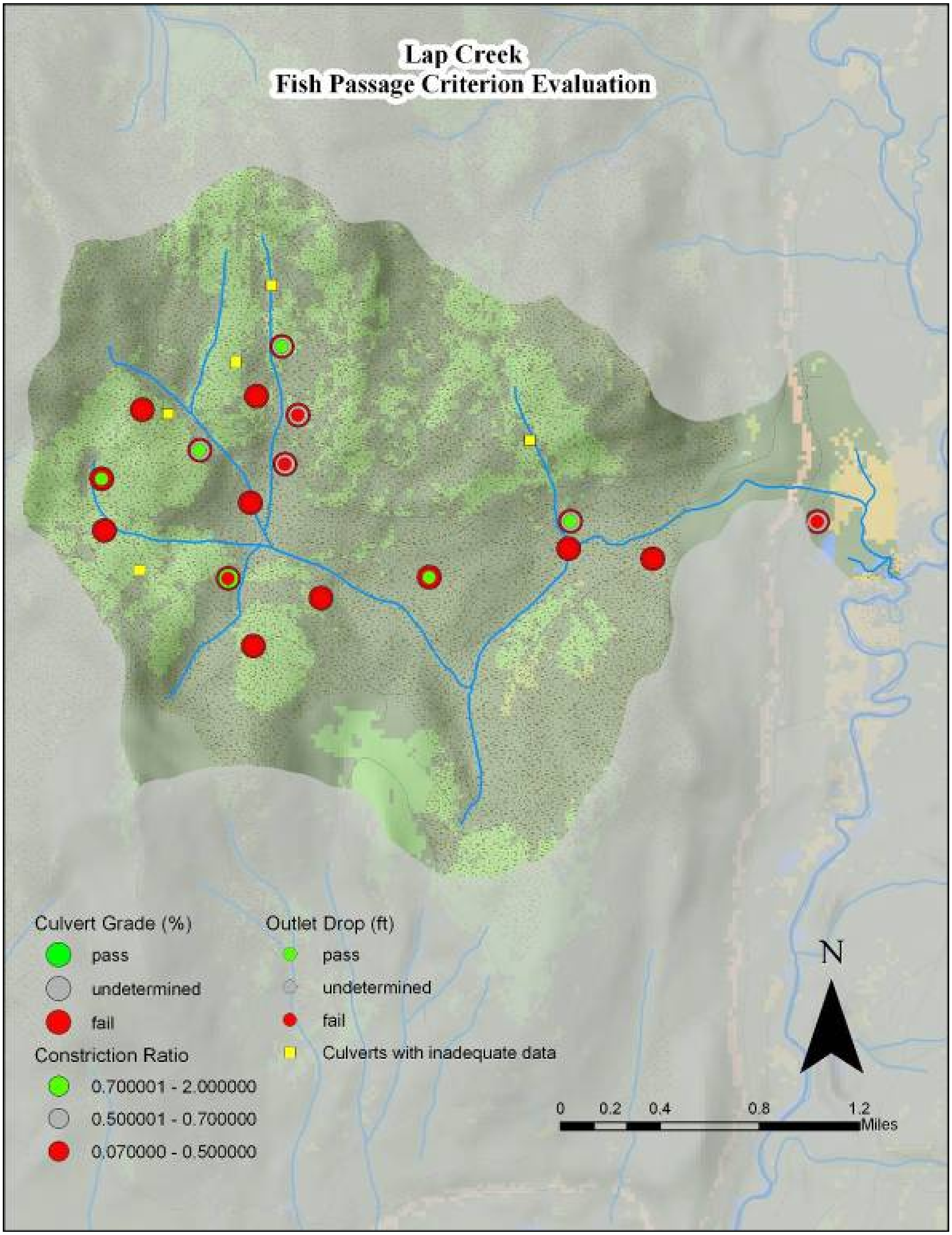


**Figure C-6. Lap Creek Fish Passage Criterion Evaluation**

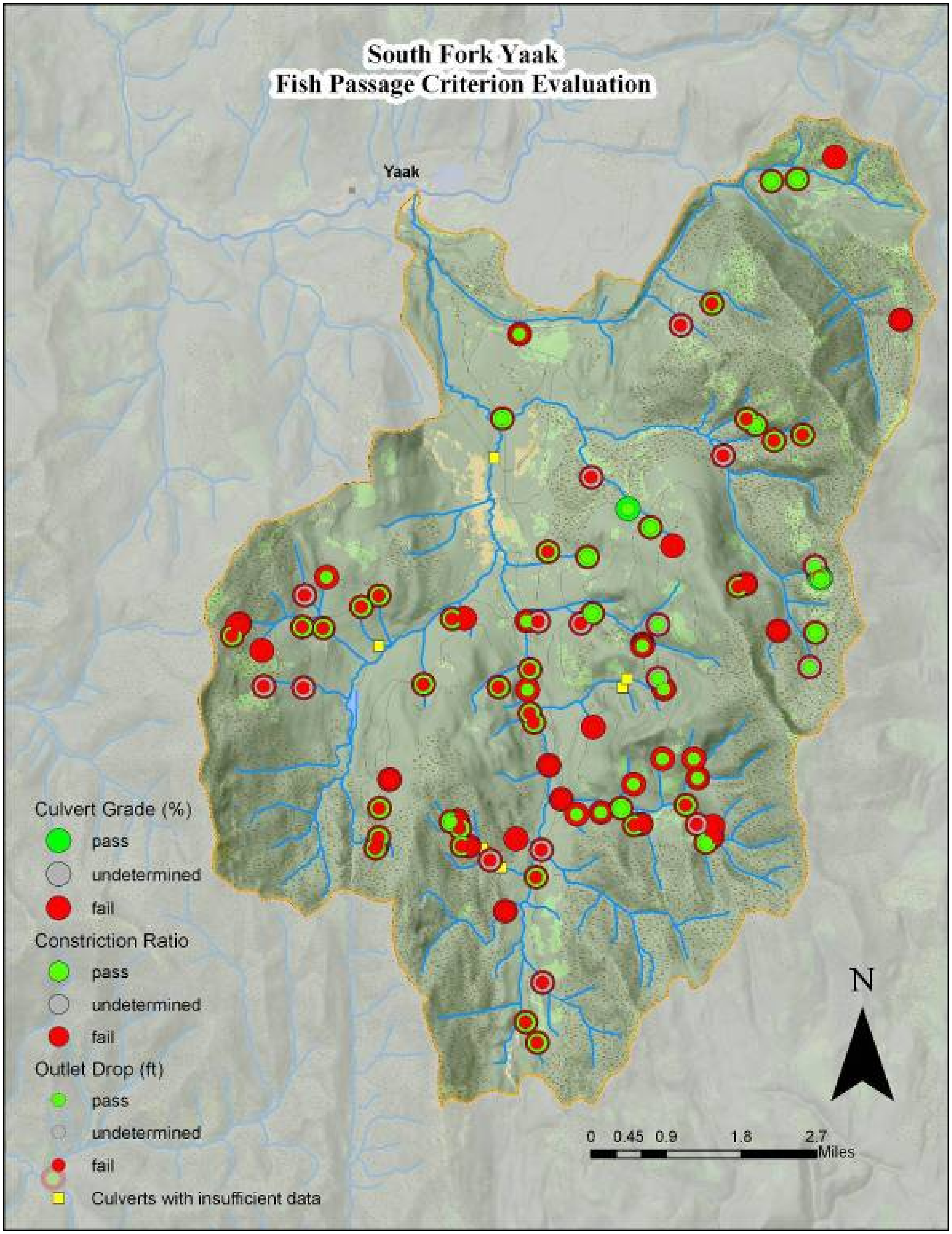


**Figure C-7. South Fork Yaak River Fish Passage Criterion Evaluation**

### 3.3.2 Culvert Failure Potential and Potential Sediment Loading

Potential road fill volumes at risk for delivery to stream channels in the event of a culvert failure were calculated using information collected during YVFC culvert assessments. Potential of culvert failure is assessed through consideration of two driving factors: peak discharge, and culvert characteristics. GIS analysis and modeling (HDS5eq.exe) were used to assess the ability of culverts to pass peak flows.

Using regression equations developed by Omang (USGS 1992), peak discharge flows were developed for the 2-, 5-, 10-, 25-, 50-, and 100-year recurring intervals for each selected culvert. Drainage area above each culvert was calculated using a digital elevation model (DEM) and the Hydrotools extension in GIS and refined manually. The average mean annual precipitation was calculated within each drainage area from a mean precipitation layer available on NRIS (Montana Average Annual Precipitation GIS layer, 1971-2000, PRISM Group).

Using culvert specifications including material, shape, mitering, dimensions, and slope, the headwater depth was calculated for each culvert at the modeled peak discharge. Headwater depths (the depth of water at a culvert inlet) were determined by the modeling program HDS5eq.exe, downloaded from the US Department of Transportation Federal Highway Administration's (FHWA) Hydraulic Engineering Software Archive website at http://www.fhwa.dot.gov/engineering/hydraulics/software.cfm.

Peak discharge, headwater depth to culvert depth ratio (Hw:D), and fill volume at risk of erosion were used to determine potential sediment delivery risk. Culverts with Hw:D of 1.5 or greater were considered at risk of failure due to the force of water backing up at the culvert inlet. Corrugated metal pipe manufacturers recommend a maximum Hw:D of 1.5; however, culvert failure does not always occur when the Hw:D is greater than 1.5. Loads generated from failure risk at Hw:D of 1.5 should be considered liberal and incorporate a margin of safety.

A full failure analysis was performed at 22 assessed culverts. As expected, as peak discharge increases, so does the percentage of culverts incapable of passing the greater flows. Potential sediment at risk in the event of a culvert failure was summarized based on calculated road fill estimates, and a Hw:D ratio of 1.5. For a Hw:D of ≤1.5, potential sediment loads range from 0 tons at the 2-year flow to 6924 tons at the 100-year flow. This estimate is based on 5 of 22 culverts that meet failure criteria.

Using the potential estimated sediment loads due to culvert failure, an average annual sediment contribution was developed. The approach used for this estimate was to distribute a portion of the road fill volume at risk in any given year based on peak discharge recurrence intervals and the likelihood of each event occurring in any given year. The analysis period used was the 100-year event with Hw:D of 1.5.

At a Hw:D of 1.5, the occurrence of a Q2 event puts 0 tons of fill at risk; a Q10 event puts 3,013 tons at risk; and so on. The sediment load at risk for a certain event is classified separately from lesser events, but the total load would include all events. Using this rationale, a Q10 event puts

3013 tons of fill at risk, and a Q50 puts 485 additional tons at risk, so a total of 3498 tons is at risk for a Q50 event.

The likelihood of peak flow occurrences were determined (i.e. the Q2 is likely to occur 50% of the time; the Q10 is likely to occur 10% of the time, etc), and the total fill at risk was multiplied by the likelihood of occurrence. So for the Hw:D scenario described above, the Q2 fill estimate of 0 tons is multiplied by 0.5 (0 x 0.5 = 0 tons), the Q10 event is multiplied by 0.10 (3013 x 0.10 = 301.3 tons), and the Q50 event is multiplied by 0.02 (485 x 0.02 = 9.7 tons). For this analysis, it was assumed that 25% of the road fill load at risk is delivered to the stream. By adding together all at-risk loads for all modeled peak flows, an average annual sediment load of 3.9 tons/culvert/year was generated for the subset of 22 culverts assessed (**Table C-5**).

**Table C-5. Estimated Annual Mean Sediment Load per Crossing Due to Culvert Failure at Hw:D ratio of 1.5 (Existing Culvert Conditions)**

| Flow | Fill at Risk (tons) at Hw:D<1.5 | Fill at Risk for Lesser Q Events | Difference between Q and Q lesser | Likelihood of Flow Occurrence | Annual Volume of Fill at Risk (tons) | Percent of at Risk Fill Delivered | Estimated Annual Sediment Delivered (tons) |
|---|---|---|---|---|---|---|---|
| Q2 | 0 | 0 | 0 | 0.5 | 0 | 0.25 | 0.00 |
| Q5 | 0 | 0 | 0 | 0.2 | 0 | 0.25 | 0.00 |
| Q10 | 3013 | 0 | 3013 | 0.1 | 301.3 | 0.25 | 75.3 |
| Q25 | 3013 | 3013 | 0 | 0.04 | 0 | 0.25 | 0.00 |
| Q50 | 3498 | 3013 | 485 | 0.02 | 9.7 | 0.25 | 2.4 |
| Q100 | 6924 | 3498 | 3426 | 0.01 | 34.2 | 0.25 | 8.5 |
| Sum of Subsample | | | | | 345.2 | | 86.3 |
| | | | | | | | |
| **Average Per Crossing (n=22)** | | | | | | | **3.9** |

**Table C-6** shows estimated annual sediment loading from culvert failure for Seventeenmile Creek, Lap Creek, and South Fork Yaak River by extrapolating the mean culvert failure sediment load to all culvert crossings.

**Table C-6. Estimated Annual Sediment Load from Culvert Failure: Seventeenmile Creek, Lap Creek, South Fork Yaak River**

| Watershed | Number of Culverts | Mean Annual Load (tons) | Total Annual Load (tons) |
|---|---|---|---|
| Seventeenmile Creek | 108 | 3.9 | 421.2 |
| Lap Creek | 18 | 3.9 | 70.2 |
| South Fork Yaak River | 109 | 3.9 | 425.1 |

When interpreting the results of this culvert assessment, it must be understood that the modeled approach used does not reflect actual loads on any given year, but represents an average modeled load over a 100-year period. The annual culvert failure loads during low-flow years will likely be substantially less than given estimates, while annual loads during high-flow years (>Q50) may be higher than given estimates. Additionally, the following considerations and assumptions may significantly affect the accuracy of mean load estimations:

- USGS flow regression equations are subject to large standard errors that may substantially overestimate or underestimate peak discharges.
- The Q10 condition was considered the minimum flow required for culvert failure.
- Culvert assessments were conducted on a small subset of culverts (22), which may not be representative of the larger set of culverts within the Seventeenmile Creek (108), Lap Creek (18), and South Fork Yaak River (109) watersheds.
- Potential culvert failure was assumed to occur when Hw:D ratios $\geq$1.5, and was based on culvert design specification given by the manufacturer. Culvert failure may not always occur when Hw:D ratio of 1.5 is exceeded, or may occur below Hw:D ratio of 1.5.
- Percent of fill at risk for delivery to streams in the event of culvert failure was estimated to be 25%.

Potential sediment loading estimates can be further refined through increasing the sampling size from 22 assessed culverts. Furthermore, as undersized culvert fail due to high flows, field assessments that allow the characterization of conditions that led to failure may assist in refining the above assumptions and lead to more accurate culvert failure loading analysis calculations. Additionally, sediment loads from culvert failure are due to episodic failures during short peak flow periods when streams maintain a higher assimilative capacity for sediment loading, and, while culvert failure loads delivered during events smaller than the Q100 flow are considered non-natural, the extent to which these loads impact impairment to beneficial uses (mainly aquatic life) is undetermined.

## 3.4 Total Estimated Road Network Sediment Load

Total existing sediment load from the road network in Seventeenmile Creek, Lap Creek, and South Fork includes sediment loads from road crossings, road parallel segments and potential culvert failure (**Table C-7**). Loads from parallel segments are not significant (see **Section 3.2**) and are therefore not calculated for the purposes of this assessment. Loads from culvert failure are based on a 100-year annual average and may not be representative of actual annual loading. Sediment loads from stream crossings is thought to be the most significant *chronic* source of sediment to streams as delivery of sediment can occur throughout the year in response to precipitation and snowmelt events.

**Table C-7. Total Estimated Road Network Sediment Load**

| Watershed | Road Sediment Sources | | | Total Load (tons/yr) |
|---|---|---|---|---|
| | **Stream Crossing Load** | **Parallel Road Load** | **Culvert Load** | |
| Seventeenmile Creek | 23.7 | NA | 85 | 108.7 |
| Lap Creek | 2.37 | NA | 14 | 16.37 |
| South Fork Yaak River | 21.3 | NA | 86 | 107.3 |

# 4.0 SEDIMENT REDUCTIONS FROM ROADS

Sediment derived form the unpaved forest road network is the primary source of anthropogenic sediment loading in the Yaak TPA, and has been identified as a cause of impairment of aquatic life uses.

As defined in ARM 17.30.623 (f) "*No increases are allowed above* ***naturally occurring*** *concentrations of sediment or suspended sediment (except as permitted in 75-5-318 , MCA) , settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.*"

***"Naturally occurring"*** *is defined as "conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied*" (ARM 17.30.602 (9)).

Estimated sediment load reductions from the forest road network are based on the assumption that some sediment from roads is acceptable as long as beneficial uses are maintained through the application of "*all reasonable land, soil and water conservation practices*." In the case of sediment from forest roads, a surrogate sediment loading condition is established that represents the application of all reasonable conservation practices and is based on the following criteria:

- Contributing road length at crossings ≤200 feet
- Road crossing density ≤1.5 crossings/mi$^2$
- Culverts on USFS maintained roads are designed to pass the 100-year flow (Q100)

The resultant sediment load from the forest road network, assuming a contributing road length of ≤200 ft, a road crossing density ≤1.5 crossings per square mile, and culverts capable of passing the 100-year flow are considered "naturally occurring." In order to estimate the acceptable sediment loading from forest roads based on these criteria, the aforementioned criteria were applied to the existing modeled sediment loads (see **Attachment A—Tables C-17, C-18, and C-19**) at the 7$^{th}$ code HUC level.

## 4.1 Contributing Road Length and Road Crossing Density Load Reductions

Sediment loads from contributing road length reductions were assessed by modeling a length reduction to 200 feet using the WEPP:Road forest road erosion prediction model. A contributing road length of 200 ft or less represents application of "reasonable conservation practices" on forest roads and may be achieved through a variety of BMPs, to be determined based on site-specific characteristics. Because the existing condition of roads within IGBC classifications 1, 2, and 3 are presently producing relatively little sediment, and the application of BMPs on these roads is limited by access considerations, contributing road length scenarios were only applied to roads that are currently open to public use (IGBC Code 4).

On IGBC Code 4 crossings where contributing road length exceeded 200 feet, contributing road lengths were reduced to the corresponding post-BMP scenario of 200 feet. No changes were made to crossing locations where the contributing road length was less than the 200 feet. Reduced mean sediment loads were then extrapolated to the watershed scale in the same manner in which the existing sediment loads were calculated. By reducing road segments to a maximum 200 foot contributing road length scenario, mean sediment loads were reduced from 0.60 tons/year to 0.13 tons/year for IGBC code 4 road crossings. **Table C-8** shows the resultant loading values (in **bold**) based on these reductions.

**Table C-8. Existing and BMP Mean Sediment Loads by KNF Road Type**

| KNF Road Classification (IGBC) | Existing Conditions | | BMP Scenario | |
|---|---|---|---|---|
| | Mean Contributing Length (ft) | Mean Sediment Load (tons/yr) | Mean Contributing Length (ft) | Mean Sediment Load (tons/yr) |
| 1 – Impassible to Motorized Vehicles | 170 | 0.001 | 170 | 0.001 |
| 2 – Restricted/Legally Gated Admin Use | 268 | 0.06 | 268 | 0.06 |
| 3 – Barriered/Legally No Admin Use | 207 | 0.11 | 207 | 0.11 |
| 4 – Open During Bear Season | 451 | 0.60 | **200** | **0.13** |

A road crossing density value of 1.5 crossings per square mile was applied to the reduced mean sediment loads given in **Section 5.1**. Watershed areas for all 7$^{th}$ code HUCs were multiplied by 1.5, and the result was multiplied by the loading rate of 0.13 tons/mile$^2$ to obtain the allowable sediment load from road surfaces for each 7$^{th}$ code HUC (**Attachment A—Tables C-17, C-18, and C-19**). Normalized to watershed area, the allowable load from road surfaces equates to ~0.20 tons/mi$^2$/yr.

## 4.2 Culvert Failure Load Reductions

The annualized load analysis examines the present sediment loading potential from culvert failure expressed as an annual one-hundred year average. The *Draft Comprehensive Evaluation Report for the Kootenai and Idaho Panhandle Proposed Land Management Plans* adopts INFISH (USDA, 1995) conservation strategies for the replacement or reconstruction of culvert crossings. These guidelines state that new, replacement and reconstructed crossings should be designed to accommodate 100-year flood flows, including associated bedload and debris (USDA, 2006). That is, as resources permit, culvert upgrades and replacements should be done as to allow passage of a Q100 event with no associated incipient culvert failure.

Based on a 100-year time period, reductions in sediment loading resulting from the upgrade of all culverts to pass a Q100 event would "*statistically*" reduce the average annual per crossing load to zero tons/year, a 100% reduction from existing conditions. In reality, however, it is unlikely that a zero load from culvert failure would be realized, as there is a small probability that a flow event greater than a Q100 event could occur during this period, resulting in failure of culverts capable of passing a Q100 event. In addition, errors in modeling assumptions or the accuracy of data used for modeling calculations have likely resulted in loading estimates that are not entirely accurate.

**Table C-9. Estimated Annual Mean Sediment Load per Crossing Due to Culvert Failure at Hw:D ratio of 1.5** (Upgraded Culvert Conditions)

| Flow | Fill at Risk (tons) at Hw:D<1.5 | Fill at Risk for Lesser Q Events | Difference between Q and Q lesser | Likelihood of Flow Occurrence | Annual Volume of Fill at Risk (tons) | Percent of At-risk Fill Delivered | Estimated Annual Sediment Delivered (tons) |
|---|---|---|---|---|---|---|---|
| Q2 | 0 | 0 | 0 | 0.5 | 0 | 0.25 | 0 |
| Q5 | 0 | 0 | 0 | 0.2 | 0 | 0.25 | 0 |
| Q10 | 0 | 0 | 0 | 0.1 | 0 | 0.25 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Q25 | 0 | 0 | 0 | 0.04 | 0 | 0.25 | 0 |
| Q50 | 0 | 0 | 0 | 0.02 | 0 | 0.25 | 0 |
| Q100 | 6924 | 0 | 6924 | 0.01 | 69.24 | 0.25 | 17.31 |
| Sum of Subsample | | | | | 69.24 | | 17.31 |
| | | | | | | | |
| **Average Per Crossing (n=22)** | | | | | | | **0.786** |

**Table C-9** shows potential annual mean sediment loading (0.786 tons/culvert/year) from culvert failure as a result of a Q100 event, assuming culverts did not fail at lesser events (all culverts failed only during a Q100 event.)

IF one assumes that:

1. Replacement and upgraded culverts are capable of passing a Q100 event

   AND

2. Sediment loading from culvert failure is greater than zero tons for any year

   THEN

3. Actual annual mean loading from culvert failure (where all culverts are capable of passing a Q100 event) is between 0 and 0.786 tons/year/culvert, or an estimated maximum of 0.786 tons/culvert/year.

For the purposes of this assessment and to derive estimates for sediment load reductions from potential culvert failure, an assumed annual sediment load per culvert (where all culverts are capable of passing a Q100 event) is estimated at a maximum of 0.786 tons/culvert/year. This theoretical value is based on modeling results and a variety of assumptions (see **Section 4.2**), and should be considered a general estimate and not a true value. As severely undersized culverts are upgraded and replaced to ones capable of passing a Q100 event, loading potential from culvert failure will be significantly reduced from an average of 3.9 tons/year/culvert to a maximum of 0.786 tons/year/culvert, resulting in a minimum 80% reduction in sediment loads from culvert failure (**Table C-10**). Achieving culvert replacement goals, however, will take many years to complete, be dependent upon available resources, and may not be entirely possible due to access restrictions and budget and resource limitations. Culvert upgrades should be part of a comprehensive watershed prioritization process and prioritized along with fish passage considerations in order to achieve full support of beneficial uses.

**Table C-10. Culvert Failure Sediment Loading Reductions**

| Watershed | Number of Culverts | Existing Mean Annual Load (tons) | Existing Total Annual Load (tons) | Upgraded Mean Annual Load (tons) | Upgraded Total Annual Load (tons) | Percent Reduction |
|---|---|---|---|---|---|---|
| Seventeenmile Creek | 108 | 3.9 | 421 | 0.786 | 85 | 80% |
| Lap Creek | 18 | 3.9 | 70 | 0.786 | 14 | 80% |

| | | | | | | |
|---|---|---|---|---|---|---|
| South Fork Yaak River | 109 | 3.9 | 425 | 0.786 | 86 | 80% |
| **Totals** | **235** | **3.9** | **917** | **0.393** | **92** | **80%** |

## 4.3 Sediment Load Reduction Summary

Estimated sediment load reductions from the forest road network are based on the assumption that some sediment from roads is acceptable as long as beneficial uses are maintained through the application of "*all reasonable land, soil and water conservation practices*." In the case of sediment from forest roads, potential sediment load reductions are estimated by applying the following conservation practices:

- Contributing road length at crossings <200 feet
- Road crossing density <1.5 crossings/mi2
- Culverts on USFS maintained roads are designed to pass the 100-year flow (Q100)

Because sediment loads from parallel road segments are not considered significant within Seventeenmile Creek, Lap Creek, and South Fork Yaak River, calculated reductions are not provided for this sediment source. Potential sediment load reductions summaries for stream crossings and culvert failure are given below in **Tables C-11 and C-12**.

**Table C-11. Sediment Load Reduction Summary: Stream Crossings**

| Watershed | Existing Stream Crossing Load (tons/yr) | Reduced Stream Crossing Load (tons/yr) | Percent Reduction |
|---|---|---|---|
| Seventeenmile Creek | 23.7 | 12.16 | 49% |
| Lap Creek | 2.37 | 1.13 | 52% |
| South Fork Yaak River | 21.3 | 12.23 | 43% |

**Table C-12. Sediment Load Reduction Summary: Culverts**

| Watershed | Existing Culvert Load (tons/yr) | Reduced Culvert Load (tons/yr) | Percent Reduction |
|---|---|---|---|
| Seventeenmile Creek | 421 | 85 | 80% |
| Lap Creek | 70 | 14 | 80% |
| South Fork Yaak River | 425 | 86 | 80% |

# 5.0 REFERENECES

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# ATTACHMENT A

## Kootenai National Forest Road Types by 7th Code HUC

## Table C-13. KNF Road Types by 7th Code HUC

| HUC7_Name | HUC6_Name | IGBC Code 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|---|
| Big Foot Cr | Upper Seventeenmile Creek | 0 | 5 | 0 | 5 | 10 |
| Flattail Cr | Upper Seventeenmile Creek | 0 | 2 | 6 | 6 | 14 |
| Hemlock Cr | Upper Seventeenmile Creek | 2 | 0 | 0 | 0 | 2 |
| Lost Fork Cr-1 | Upper Seventeenmile Creek | 6 | 9 | 0 | 0 | 15 |
| Lost Fork Cr-2 | Upper Seventeenmile Creek | 1 | 2 | 0 | 0 | 3 |
| Seventeenmile Cr U-1 | Upper Seventeenmile Creek | 0 | 4 | 0 | 2 | 6 |
| Seventeenmile Cr U-2 | Upper Seventeenmile Creek | 0 | 4 | 4 | 7 | 15 |
| Bridle Cr | Lower Seventeenmile Creek | 1 | 0 | 0 | 0 | 1 |
| Conn Cr | Lower Seventeenmile Creek | 13 | 0 | 0 | 0 | 13 |
| Crum Gulch | Lower Seventeenmile Creek | 0 | 0 | 0 | 1 | 1 |
| Mule Cr | Lower Seventeenmile Creek | 6 | 0 | 0 | 0 | 6 |
| Pelham Cr | Lower Seventeenmile Creek | 4 | 0 | 0 | 0 | 4 |
| Seventeenmile Cr L | Lower Seventeenmile Creek | 4 | 0 | 0 | 13 | 17 |
| Seventeenmile Cr NF | Lower Seventeenmile Creek | 0 | 0 | 0 | 1 | 1 |
| Saddle Cr | Lower Seventeenmile Creek | 0 | 0 | 0 | 0 | 0 |
| Grush Gulch | Lower Seventeenmile Creek | 0 | 0 | 0 | 0 | 0 |
| Sheepherder Cr | Lower Seventeenmile Creek | 0 | 0 | 0 | 0 | 0 |
| Papoose Cr | Lower Seventeenmile Creek | 0 | 0 | 0 | 0 | 0 |
| **Seventeenmile Creek Totals** | | **37** | **26** | **10** | **35** | **108** |
| Beaver Cr-1 | South Fork Yaak River | 1 | 0 | 1 | 0 | 2 |
| Beaver Cr-2 | South Fork Yaak River | 1 | 0 | 1 | 4 | 6 |
| Browning Cr | South Fork Yaak River | 0 | 0 | 0 | 1 | 1 |
| Can Cr | South Fork Yaak River | 3 | 2 | 0 | 0 | 5 |
| Clay Cr-1 | South Fork Yaak River | 0 | 0 | 1 | 0 | 1 |
| Clay Cr-2 | South Fork Yaak River | 2 | 9 | 0 | 4 | 15 |
| Dutch Cr | South Fork Yaak River | 3 | 5 | 0 | 0 | 8 |
| Fix Cr | South Fork Yaak River | 0 | 1 | 1 | 0 | 2 |
| Fowler Cr-1 | South Fork Yaak River | 2 | 0 | 4 | 0 | 6 |
| Fowler Cr-2 | South Fork Yaak River | 0 | 0 | 8 | 2 | 10 |
| Hartman Cr | South Fork Yaak River | 0 | 0 | 3 | 1 | 4 |
| Kelsey Cr | South Fork Yaak River | 3 | 3 | 3 | 3 | 12 |
| Yaak R SF Trib-3 | South Fork Yaak River | 9 | 0 | 0 | 0 | 9 |
| Yaak R SF Trib-4 | South Fork Yaak River | 0 | 0 | 0 | 1 | 1 |
| Yaak R SF-2 | South Fork Yaak River | 4 | 3 | 1 | 7 | 15 |
| Yodkin Cr | South Fork Yaak River | 1 | 1 | 6 | 0 | 8 |
| Zulu Cr-1 | South Fork Yaak River | 1 | 4 | 0 | 2 | 7 |
| Zulu Cr-2 | South Fork Yaak River | 6 | 3 | 0 | 2 | 11 |
| Yaak R SF | South Fork Yaak River | 0 | 0 | 0 | 0 | 0 |
| Yaak R SF Trib | South Fork Yaak River | 0 | 0 | 0 | 0 | 0 |
| Yaak R SF Trib | South Fork Yaak River | 0 | 0 | 0 | 0 | 0 |
| Smoot Cr | South Fork Yaak River | 0 | 0 | 0 | 0 | 0 |
| **South Fork Yaak River Totals** | | **36** | **31** | **29** | **27** | **123** |
| **Lap Cr Total** | | **6** | **0** | **16** | **1** | **23** |

**Table C-14. Seventeenmile Creek: Existing Annual Sediment Loads from Road Crossings**

| Seventeen Mile Creek Watershed | | No. of crossings by IGBC Code | | | | Existing Annual Sediment Load by IGBC Code (tons/yr) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **HUC7_Name** | **Area (mi2)** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **TOTAL LOAD** |
| Bridle Cr | 1.7 | 1 | 0 | 0 | 0 | 0.001 | 0 | 0 | 0 | 0.00 |
| Conn Cr | 2.3 | 13 | 0 | 0 | 0 | 0.013 | 0 | 0 | 0 | 0.01 |
| Crum Gulch | 2.1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.6 | 0.60 |
| Grush Gulch | 2.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Mule Cr | 1.7 | 6 | 0 | 0 | 0 | 0.006 | 0 | 0 | 0 | 0.01 |
| Papoose Cr | 2.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Pelham Cr | 0.5 | 4 | 0 | 0 | 0 | 0.004 | 0 | 0 | 0 | 0.00 |
| Saddle Cr | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Seventeenmile Cr L | 10.3 | 4 | 0 | 0 | 13 | 0.004 | 0 | 0 | 7.8 | 7.80 |
| Seventeenmile Cr NF | 4.2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.6 | 0.60 |
| Sheepherder Cr | 1.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Big Foot Cr | 3.0 | 0 | 5 | 0 | 5 | 0 | 0.3 | 0 | 3 | 3.30 |
| Flattail Cr | 10.3 | 0 | 2 | 6 | 6 | 0 | 0.12 | 0.66 | 3.6 | 4.38 |
| Hemlock Cr | 3.7 | 2 | 0 | 0 | 0 | 0.002 | 0 | 0 | 0 | 0.00 |
| Lost Fork Cr-1 | 3.4 | 6 | 9 | 0 | 0 | 0.006 | 0.54 | 0 | 0 | 0.55 |
| Lost Fork Cr-2 | 2.4 | 1 | 2 | 0 | 0 | 0.001 | 0.12 | 0 | 0 | 0.12 |
| Seventeenmile Cr U-1 | 3.4 | 0 | 4 | 0 | 2 | 0 | 0.24 | 0 | 1.2 | 1.44 |
| Seventeenmile Cr U-2 | 5.6 | 0 | 4 | 4 | 7 | 0 | 0.24 | 0.44 | 4.2 | 4.88 |
| **Totals** | **62.4** | **37** | **26** | **10** | **35** | **0.037** | **1.56** | **1.1** | **21** | **23.7** |

**Table C-15. Lap Creek Existing Annual Sediment Loads from Road Crossings**

| South Fork Yaak River Watershed | | No. of crossings by IGBC Code | | | | Existing Annual Sediment Load by IGBC Code (tons/yr) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **HUC7_Name** | **Area (mi2)** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **TOTAL LOAD** |
| Lap Cr | 5.8 | 6 | 0 | 16 | 1 | 0.006 | 0 | 1.76 | 0.6 | 2.37 |
| **Totals** | **5.8** | **6** | **0** | **16** | **1** | **0.006** | **0** | **1.76** | **0.6** | **2.37** |

**Table C-16. South Fork Yaak River: Existing Annual Sediment Loads from Road Crossings**

| South Fork Yaak River Watershed | | No. of crossings by IGBC Code | | | | Existing Annual Sediment Load by IGBC Code (tons/yr) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **HUC7_Name** | **Area (mi2)** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **TOTAL LOAD** |
| Beaver Cr-1 | 3.9 | 1 | 0 | 1 | 0 | 0.001 | 0 | 0.11 | 0 | 0.11 |
| Beaver Cr-2 | 4.4 | 1 | 0 | 1 | 4 | 0.001 | 0 | 0.11 | 2.4 | 2.51 |
| Browning Cr | 1.0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.6 | 0.60 |
| Can Cr | 1.4 | 3 | 2 | 0 | 0 | 0.003 | 0.12 | 0 | 0 | 0.12 |
| Clay Cr-1 | 4.3 | 0 | 0 | 1 | 0 | 0 | 0 | 0.11 | 0 | 0.11 |
| Clay Cr-2 | 5.0 | 2 | 9 | 0 | 4 | 0.002 | 0.54 | 0 | 2.4 | 2.94 |
| Dutch Cr | 2.4 | 3 | 5 | 0 | 0 | 0.003 | 0.3 | 0 | 0 | 0.30 |
| Fix Cr | 0.9 | 0 | 1 | 1 | 0 | 0 | 0.06 | 0.11 | 0 | 0.17 |
| Fowler Cr-1 | 3.7 | 2 | 0 | 4 | 0 | 0.002 | 0 | 0.44 | 0 | 0.44 |
| Fowler Cr-2 | 5.3 | 0 | 0 | 8 | 2 | 0 | 0 | 0.88 | 1.2 | 2.08 |
| Hartman Cr | 1.3 | 0 | 0 | 3 | 1 | 0 | 0 | 0.33 | 0.6 | 0.93 |

**Table C-16. South Fork Yaak River: Existing Annual Sediment Loads from Road Crossings**

| South Fork Yaak River Watershed | | No. of crossings by IGBC Code | | | | Existing Annual Sediment Load by IGBC Code (tons/yr) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| HUC7_Name | Area (mi2) | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | TOTAL LOAD |
| Kelsey Cr | 2.0 | 3 | 3 | 3 | 3 | 0.003 | 0.18 | 0.33 | 1.8 | 2.31 |
| Smoot Cr | 2.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Yaak R SF | 1.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Yaak R SF-2 | 10.2 | 4 | 3 | 1 | 7 | 0.004 | 0.18 | 0.11 | 4.2 | 4.49 |
| Yaak R SF Trib-1 | 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Yaak R SF Trib-2 | 1.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00 |
| Yaak R SF Trib-3 | 1.1 | 9 | 0 | 0 | 0 | 0.009 | 0 | 0 | 0 | 0.01 |
| Yaak R SF Trib-4 | 1.3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.6 | 0.60 |
| Yodkin Cr | 1.9 | 1 | 1 | 6 | 0 | 0.001 | 0.06 | 0.66 | 0 | 0.72 |
| Zulu Cr-1 | 2.0 | 1 | 4 | 0 | 2 | 0.001 | 0.24 | 0 | 1.2 | 1.44 |
| Zulu Cr-2 | 3.3 | 6 | 3 | 0 | 2 | 0.006 | 0.18 | 0 | 1.2 | 1.39 |
| **Totals** | **62.7** | **36** | **31** | **29** | **27** | **0.036** | **1.86** | **3.19** | **16.2** | **21.3** |

**Table C-17. Seventeenmile Creek Road Surface Sediment Loading Reductions**

| HUC 7 Name | Existing Load (tons/yr) | Allowable Load (tons/yr) | Existing Load (per mi$^2$) | Allowable Load (per mi$^2$) | Percent Reduction |
|---|---|---|---|---|---|
| Bridle Cr | 0.00 | 0.32 | 0.00 | 0.20 | |
| Conn Cr | 0.01 | 0.45 | 0.01 | 0.20 | |
| Crum Gulch | 0.60 | 0.41 | 0.28 | 0.20 | 31.2% |
| Grush Gulch | 0.00 | 0.45 | 0.00 | 0.20 | |
| Mule Cr | 0.01 | 0.32 | 0.00 | 0.20 | |
| Papoose Cr | 0.00 | 0.50 | 0.00 | 0.20 | |
| Pelham Cr | 0.00 | 0.09 | 0.01 | 0.20 | |
| Saddle Cr | 0.00 | 0.24 | 0.00 | 0.20 | |
| Seventeenmile Cr L | 7.80 | 2.01 | 0.76 | 0.20 | 74.2% |
| Seventeenmile Cr NF | 0.60 | 0.81 | 0.14 | 0.20 | |
| Sheepherder Cr | 0.00 | 0.36 | 0.00 | 0.20 | |
| Big Foot Cr | 3.30 | 0.58 | 1.11 | 0.20 | 82.5% |
| Flattail Cr | 4.38 | 2.02 | 0.42 | 0.20 | 54.0% |
| Hemlock Cr | 0.00 | 0.71 | 0.00 | 0.20 | |
| Lost Fork Cr-1 | 0.55 | 0.67 | 0.16 | 0.20 | |
| Lost Fork Cr-2 | 0.12 | 0.47 | 0.05 | 0.20 | |
| Seventeenmile Cr U-1 | 1.44 | 0.66 | 0.43 | 0.20 | 54.4% |
| Seventeenmile Cr U-2 | 4.88 | 1.09 | 0.87 | 0.20 | 77.7% |
| **Seventeenmile Creek Totals** | **23.70** | **12.16** | **0.38** | **0.20** | **48.7%** |

**Table C-18. Lap Creek Road Surface Sediment Loading Reductions**

| HUC 7 Name | Existing Load (tons/yr) | Allowable Load (tons/yr) | Existing Load (per mi2) | Allowable Load (per mi2) | Percent Reduction |
|---|---|---|---|---|---|
| Lap Creek | 2.37 | 1.13 | 0.41 | 0.20 | 52.4% |
| **Lap Creek Totals** | **2.37** | **1.13** | **0.41** | **0.20** | **52.4%** |

**Table C-19. South Fork Yaak River Road Surface Sediment Loading Reductions**

| HUC 7 Name | Existing Load (tons/yr) | Allowable Load (tons/yr) | Existing Load (per mi2) | Allowable Load (per mi2) | Percent Reduction |
|---|---|---|---|---|---|
| Beaver Cr-1 | 0.11 | 0.77 | 0.03 | 0.20 | |
| Beaver Cr-2 | 2.51 | 0.85 | 0.57 | 0.20 | 66.0% |
| Browning Cr | 0.60 | 0.19 | 0.61 | 0.20 | 68.2% |
| Can Cr | 0.12 | 0.27 | 0.09 | 0.20 | |
| Clay Cr-1 | 0.11 | 0.84 | 0.03 | 0.20 | |
| Clay Cr-2 | 2.94 | 0.98 | 0.59 | 0.20 | 66.8% |
| Dutch Cr | 0.30 | 0.46 | 0.13 | 0.20 | |
| Fix Cr | 0.17 | 0.17 | 0.19 | 0.20 | |
| Fowler Cr-1 | 0.44 | 0.72 | 0.12 | 0.20 | |
| Fowler Cr-2 | 2.08 | 1.03 | 0.39 | 0.20 | 50.3% |
| Hartman Cr | 0.93 | 0.25 | 0.73 | 0.20 | 73.4% |
| Kelsey Cr | 2.31 | 0.38 | 1.17 | 0.20 | 83.4% |
| Smoot Cr | 0.00 | 0.45 | 0.00 | 0.20 | |
| Yaak R SF | 0.00 | 0.37 | 0.00 | 0.20 | |
| Yaak R SF-2 | 4.49 | 1.99 | 0.44 | 0.20 | 55.7% |
| Yaak R SF Trib-1 | 0.00 | 0.30 | 0.00 | 0.20 | |
| Yaak R SF Trib-2 | 0.00 | 0.32 | 0.00 | 0.20 | |
| Yaak R SF Trib-3 | 0.01 | 0.22 | 0.01 | 0.20 | |
| Yaak R SF Trib-4 | 0.60 | 0.26 | 0.45 | 0.20 | 56.3% |
| Yodkin Cr | 0.72 | 0.37 | 0.38 | 0.20 | 48.8% |
| Zulu Cr-1 | 1.44 | 0.39 | 0.72 | 0.20 | 72.8% |
| Zulu Cr-2 | 1.39 | 0.65 | 0.41 | 0.20 | 52.9% |
| **South Fork Yaak River Totals** | **21.29** | **12.23** | **0.34** | **0.20** | **42.5%** |

# ATTACHMENT B

## WEPP: Road Modeling Results for Field Assessed Road Crossings

**Table C-20. WEPP. Road Modeling Results From Field Assessed Crossings**

| Yrs | Climate | Soil | Rock (%) | Surface, traffic | Design | Road grad (%) | Road length | Road width | Fill grad | Fill length | Buff grad | Buff length | Precip | Rain runoff | Snow runoff | Sed road (lb/yr) | Sed profile (lb/yr) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | TROY(248395) + | silt loam | 30% | graveled high | outsloped unrutted | 2 | 243 | 15.5 ft | 55% | 1 ft | 0.30% | 1 ft | 37.74 in | 1.31 in | 0.04 in | 513.6 | 320.45 | SFY-1AB |
| 30 | BURKE 2 ENE + | silt loam | 75% | graveled none | outsloped rutted | 4 | 89 | 13 ft | 75% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.42 in | 0.39 in | 41.21 | 30.33 | SFY-2A |
| 30 | BURKE 2 ENE + | sandy loam | 90% | graveled none | outsloped unrutted | 6 | 162 | 13 ft | 100% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.25 in | 0.25 in | 89.68 | 60.87 | SFY-3A |
| 30 | BURKE 2 ENE + | silt loam | 50% | graveled high | outsloped unrutted | 2 | 241 | 16 ft | 85% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.03 in | 0.25 in | 362.23 | 221.48 | SFY-5A |
| 30 | Burke 2 ENE + | loam | 10% | native none | outsloped rutted | 5 | 122 | 19 ft | 5% | 119 ft | 0.30% | 1 ft | 48.90 in | 0.60 in | 0.12 in | 2.19 | 4.74 | SFY-6A - Road to Fillslope |
| 30 | BURKE 2 ENE + | silt loam | 40% | graveled none | outsloped rutted | 1 | 245 | 16 ft | 36% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.54 in | 0.41 in | 108.46 | 62.52 | SFY-7A |
| 30 | Burke 2 ENE + | loam | 0% | native none | outsloped rutted | 2 | 95 | 12 ft | 2% | 92 ft | 0.30% | 1 ft | 48.90 in | 0.54 in | 0.10 in | 1.18 | 2.24 | SFY-8A - Road to fillslope |
| 30 | Burke 2 ENE + | loam | 0% | native none | outsloped rutted | 2 | 480 | 10 ft | 2% | 477 ft | 0.30% | 1 ft | 48.90 in | 0.42 in | 0.09 in | 0.98 | 7.39 | SFY-9A Road to fillslope - added 2 segments |
| 30 | TROY(248395) + | silt loam | 20% | graveled high | outsloped unrutted | 4 | 250 | 24 ft | 56% | 1 ft | 0.30% | 1 ft | 37.74 in | 1.70 in | 0.08 in | 1080.37 | 805.62 | SFY-10A |
| 30 | BURKE 2 ENE + | loam | 10% | native none | insloped bare | 4 | 140 | 17 ft | 65% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.69 in | 8.69 in | 138.87 | 107.91 | SFY-11A |
| 30 | BURKE 2 ENE + | silt loam | 10% | native none | insloped vegetated | 2 | 500 | 22 ft | 75% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.73 in | 9.91 in | 313.96 | 227.46 | SFY-12A |
| 30 | BURKE 2 ENE + | loam | 60% | graveled low | outsloped rutted | 7 | 366 | 24 ft | 75% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.92 in | 0.53 in | 913.41 | 851.2 | SFY-13A |
| 30 | Burke 2 ENE + | silt loam | 15% | native none | outsloped rutted | 6 | 250 | 15 ft | 42% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.69 in | 9.04 in | 496.71 | 387.1 | SFY-14A |
| 30 | Burke 2 ENE + | loam | 0% | native none | outsloped rutted | 1 | 47 | 11 ft | 1% | 44 ft | 0.30% | 1 ft | 48.90 in | 0.55 in | 0.10 in | 1.04 | 0.75 | SFY-15A - Road to fillslope |
| 30 | BURKE 2 ENE + | silt loam | 25% | graveled none | insloped vegetated | 4 | 865 | 26 ft | 40% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.80 in | 0.44 in | 837.83 | 574.76 | SFY-4B |
| 30 | BURKE 2 ENE + | silt loam | 15% | native none | outsloped rutted | 0.50 | 75 | 21 ft | 40% | 1 ft | 0.30% | 1 ft | 48.90 in | 2.73 in | 6.67 in | 47.48 | 32.21 | SFY-5B |
| 30 | BURKE 2 ENE + | silt loam | 15% | native none | outsloped unrutted | 2.20 | 525 | 22 ft | 42% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.83 in | 3.20 in | 433.31 | 224.11 | SFY-6B |
| 30 | Burke 2 ENE + | silt loam | 5% | native none | outsloped rutted | 3.50 | 50 | 15 ft | 3.50 % | 47 ft | 0.30% | 1 ft | 48.90 in | 0.54 in | 0.12 in | 1.62 | 1.65 | SFY-7B Road to fillslope |
| | BURKE 2 ENE + | silt loam | 25% | graveled low | insloped bare | 4.50 | 1250 | 25 ft | 40% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.82 in | 0.44 in | 2692.42 | 2476.78 | SFY-8B-LOW, used 1/2 length and doubled results |
| 30 | BURKE 2 ENE + | silt loam | 15% | native none | outsloped rutted | 5.70 | 255 | 41 ft | 30% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.86 in | 9.60 in | 1464.97 | 1141.73 | SFY-9B |
| 30 | BURKE 2 ENE + | silt loam | 25% | native none | outsloped rutted | 7.30 | 250 | 18 ft | 12% | 1 ft | 0.30% | 1 ft | 48.90 in | 4.15 in | 10.05 in | 783.93 | 612.32 | SFY-10B |
| 30 | BURKE 2 ENE + | silt loam | 20% | graveled high | outsloped unrutted | 4.12 | 365 | 15 ft | 30% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.46 in | 0.30 in | 784.52 | 467.77 | SFY-11B - Reduce width to 15 feet |

**Table C-20. WEPP. Road Modeling Results From Field Assessed Crossings**

| Yrs | Climate | Soil | Rock (%) | Surface, traffic | Design | Road grad (%) | Road length | Road width | Fill grad | Fill length | Buff grad | Buff length | Precip | Rain runoff | Snow runoff | Sed road (lb/yr) | Sed profile (lb/yr) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Burke 2 ENE + | silt loam | 10% | native none | insloped vegetated | 1 | 60 | 18 ft | 1% | 57 ft | 0.30% | 1 ft | 48.90 in | 0.51 in | 0.13 in | 1.75 | 1.45 | SFY-12B Road to fillslope |
| 30 | Burke 2 ENE + | silt loam | 5% | native none | outsloped unrutted | 2 | 40 | 12 ft | 1% | 37 ft | 0.30% | 1 ft | 48.90 in | 0.60 in | 0.16 in | 1.2 | 0.33 | SFY-13B Road to fillslope |
| **Average - South Fork of Yaak River** | | | | | | | **290.21** | | | | | | | | | **463.04** | **359.30** | **lb/yr** |
| | | | | | | | | | | | | | | | | **0.23** | **0.18** | **tons/yr** |
| 30 | BURKE 2 ENE + | silt loam | 10% | native low | outsloped rutted | 2 | 130 | 18 ft | 51% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.05 in | 6.32 in | 72.96 | 59.89 | LSC-1A |
| 30 | TROY(248395) + | silt loam | 35% | graveled high | outsloped unrutted | 3 | 225 | 38 ft | 80% | 1 ft | 0.30% | 1 ft | 37.74 in | 1.76 in | 0.11 in | 1329.31 | 1068.5 | SML-1-B |
| 30 | TROY(248395) + | silt loam | 20% | native low | outsloped unrutted | 1 | 360 | 18 ft | 55% | 1 ft | 0.30% | 1 ft | 37.74 in | 1.75 in | 0.70 in | 185.94 | 90.59 | SML-2B - Modeled - native, low |
| | TROY(248395) + | silt loam | 25% | graveled low | outsloped unrutted | 5 | 625 | 20 ft | 30% | 1 ft | 0.30% | 1 ft | 37.74 in | 1.66 in | 0.08 in | 599.18 | 441.55 | SML-3B - Modeled gravel, low |
| 30 | TROY(248395) + | silt loam | 30% | graveled high | outsloped unrutted | 5 | 725 | 22 ft | 40% | 1 ft | 0.30% | 1 ft | 37.74 in | 1.68 in | 0.09 in | 2761.92 | 2097.17 | SML-4B |
| 30 | Troy (248395) + | silt loam | 0% | native none | outsloped unrutted | 5 | 100 | 16 ft | 5% | 97 ft | 0.30% | 1 ft | 37.74 in | 0.60 in | 0.02 in | 2.07 | 1.13 | SML-5B Road to fillslope |
| 30 | Troy (248395) + | silt loam | 0% | native none | outsloped unrutted | 2 | 50 | 25 ft | 5% | 47 ft | 0.30% | 1 ft | 37.74 in | 0.71 in | 0.04 in | 2.87 | 1.34 | SML-6B Road to fillslope |
| **Average - Lower Seventeenmile Creek:** | | | | | | | **316.43** | | | | | | | | | **707.75** | **537.17** | **lb/yr** |
| | | | | | | | | | | | | | | | | **0.35** | **0.27** | **tons/yr** |
| 30 | TROY (248395) + | silt loam | 15% | native low | outsloped rutted | 3 | 322 | 12 ft | 48% | 1 ft | 0.30% | 1 ft | 37.74 in | 3.89 in | 3.77 in | 275.65 | 248.66 | USC-1A |
| 30 | BURKE 2 ENE + | silt loam | 5% | native low | outsloped rutted | 3 | 700 | 20 ft | 54% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.55 in | 7.93 in | 2511.28 | 2213.34 | USC-3A |
| 30 | BURKE 2 ENE + | loam | 5% | native none | outsloped unrutted | 5 | 96 | 22 ft | 28% | 1 ft | 0.30% | 1 ft | 48.90 in | 2.35 in | 4.47 in | 93.05 | 55.41 | USC-4A |
| 30 | BURKE 2 ENE + | silt loam | 5% | native low | outsloped rutted | 5 | 627 | 19 ft | 72% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.67 in | 8.03 in | 4661.78 | 3873.89 | USC-5A |
| 30 | BURKE 2 ENE + | loam | 10% | native none | outsloped rutted | 1.50 | 180 | 14 ft | 45% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.66 in | 9.01 in | 70.75 | 48.57 | USC-6A |
| 30 | BURKE 2 ENE + | silt loam | 20% | native none | outsloped rutted | 7 | 555 | 14 ft | 64% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.56 in | 7.29 in | 594.02 | 457.59 | USC-7A - Modeled 2 segments (inslope and outslope) and added results |
| 30 | BURKE 2 ENE + | silt loam | 30% | native low | outsloped rutted | 2 | 315 | 17 ft | 64% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.97 in | 8.39 in | 240.87 | 211.95 | USC-8A |
| 30 | Burke 2 ENE + | loam | 5% | native none | outsloped unrutted | 1 | 50 | 12 ft | 1% | 47 ft | 0.30% | 1 ft | 48.48 in | 0.64 in | 0.14 in | 1.17 | 0.4 | USC-9A Road to fillslope |
| 30 | BURKE 2 ENE + | silt loam | 70% | graveled low | outsloped rutted | 1 | 345 | 13 ft | 58% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.23 in | 0.41 in | 73.45 | 73.23 | USC-10A |

**Table C-20. WEPP. Road Modeling Results From Field Assessed Crossings**

| Yrs | Climate | Soil | Rock (%) | Surface, traffic | Design | Road grad (%) | Road length | Road width | Fill grad | Fill length | Buff grad | Buff length | Precip | Rain runoff | Snow runoff | Sed road (lb/yr) | Sed profile (lb/yr) | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | BURKE 2 ENE + | silt loam | 50% | native low | insloped vegetated | 5 | 1000 | 25 ft | 46% | 1 ft | 0.30% | 1 ft | 48.90 in | 5.80 in | 10.22 in | 6268.35 | 5773.65 | USC-11A |
| 30 | BURKE 2 ENE + | loam | 5% | native none | outsloped rutted | 0.50 | 195 | 15 ft | 50% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.65 in | 9.03 in | 83.24 | 58.28 | USC-12A |
| 30 | BURKE 2 ENE + | loam | 5% | native none | outsloped rutted | 2 | 252 | 11 ft | 60% | 1 ft | 0.30% | 1 ft | 48.90 in | 3.85 in | 9.54 in | 113.31 | 82.08 | USC-13A |
| 30 | Burke 2 ENE + | silt loam | 80% | native none | outsloped rutted | 6 | 294 | 14 ft | 6% | 291 ft | 0.30% | 1 ft | 48.90 in | 0.74 in | 0.29 in | 10.13 | 8.49 | USC-14A Road to fillslope |
| 30 | BURKE 2 ENE + | loam | 95% | graveled none | insloped vegetated | 5 | 184 | 13 ft | 32% | 1 ft | 0.30% | 1 ft | 48.90 in | 1.91 in | 0.51 in | 88.62 | 63.22 | USC-15A |
| **Average = Upper Seventeenmile Creek** | | | | | | | **365.36** | | | | | | | | | **1077.55** | **940.63** | **lb/yr** |
| | | | | | | | | | | | | | | | | **0.54** | **0.47** | **tons/yr** |
| 30 | Burke 2 ENE + | loam | 50% | graveled none | outsloped rutted | 5 | 450 | 19 ft | 5% | 447 ft | 0.30% | 1 ft | 48.90 in | 0.66 in | 0.14 in | 2.45 | 21.57 | LC-1A, Road to fillslope |
| 30 | Troy (248395) + | loam | 0% | native none | outsloped rutted | 0.50 | 150 | 13 ft | 5% | 147 ft | 0.30% | 1 ft | 37.74 in | 0.57 in | 0.02 in | 1.3 | 6.62 | LC-2A Road to fillslope |
| **Average - Lap Creek** | | | | | | | **300.00** | | | | | | | | | **1.88** | **14.10** | **lb/yr** |
| | | | | | | | | | | | | | | | | **0.00** | **0.01** | **tons/yr** |
| **Total Seventeenmile Average (Upper and Lower):** | | | | | | | | | | | | | | | | **954.28** | **806.14** | **lb/yr** |
| | | | | | | | | | | | | | | | | **0.48** | **0.40** | **tons/yr** |
| **Parallel Segments Removed from Model Results** | | | | | | | | | | | | | | | | | | |
| 30 | Burke 2 ENE + | sandy loam | 50% | graveled none | outsloped unrutted | 3 | 140 | 13 ft | 25% | 3 | 40% | 70 | 48.90 in | 0.31 in | 0.00 in | 68.54 | 38.68 | SFY-4A-P |
| 30 | Troy (248395) + | silt loam | 7% | graveled low | outsloped rutted | 7 | 800 | 20 ft | 60% | 20 ft | 2% | 10 ft | 37.74 in | 1.56 in | 0.12 in | 2877.54 | 2267.69 | USC-2A-P |
| | | | | | | | | | | | | | | | | **1473.04** | **1153.19** | **lb/yr** |
| | | | | | | | | | | | | | | | | **0.74** | **0.58** | **tons/yr** |
| **Decommissioned Crossings Removed from Results** | | | | | | | | | | | | | | | | | | |
| 30 | Burke 2 ENE + | silt loam | 20% | native none | outsloped unrutted | 22 | 91 | 30 ft | 22% | 88 ft | 0.30% | 1 ft | 48.90 in | 1.31 in | 1.08 in | 36.37 | 14.66 | SFY-2B Road to fillslope |
| 30 | Burke 2 ENE + | silt loam | 25% | native none | outsloped unrutted | 22 | 137 | 44 ft | 22% | 134 ft | 0.30% | 1 ft | 48.90 in | 1.28 in | 1.10 in | 88.84 | 29.1 | SFY-3B Road to fillslope |

# ATTACHMENT C

## WEPP: Road Model Adjustments

**WEPP: Road Model Adjustments**
Heavily vegetated road conditions encountered in the Yaak TPA are not properly represented in the standard WEPP:Road assumption. As a result, William J. Elliott, author of the model, was consulted to determine how best to represent these roads within the confines of the model.

There are three traffic scenarios available in the model. For roads where vegetation has grown up on the edges, the no traffic scenario is most appropriate as this scenario grows a limited amount of vegetation on the road. It uses the same plant growth for the road that the high traffic used for the fillslope. The following table explains the model assumptions for the three traffic scenarios:

| **Traffic** | **High** | **Low** | **None** |
|---|---|---|---|
| Erodibility | 100% | 25% | 25% |
| Hydraulic Conductivity | 100% | 100% | 100% |
| Vegetation on Road Surface | 0 | 0 | 50% |
| Vegetation on fill | 50% | 50% | 100% Forested |
| Buffer | Forested | Forested | Forested |

Based on conversations with Dr. Elliott, it was not appropriate to use the forest buffer to describe the road as the hydraulic conductivity of the soil would be too high. However, the hydraulic conductivity of the fillslope would be reasonable to use to describe the road surface for a fully forested scenario. This means, for the fully vegetated/forested road surface scenario, minimize the road segment length, put the remainder of the road surface length and gradient into the fillslope box, and minimize the buffer length and gradient at stream crossings. This was the approach that was used in the modeling work, and is noted as "Road to Fillslope" in the comment column of **Attachment B**.

# ATTACHMENT D

## Field Assessment Site Location Data

**Table C-21. Field Assessment Site Location Data**

| LOCATION ID | HUC_6TH CODE | X | Y | Z |
|---|---|---|---|---|
| LC-1A | Lap Creek | -115.6871 | 48.8820 | 3581.53 |
| LC-2A | Lap Creek | -115.6867 | 48.8801 | 3441.08 |
| SFY-10A | South Fork Yaak River | -115.6630 | 48.8125 | 3279.02 |
| SFY-10B | South Fork Yaak River | -115.6272 | 48.7722 | 4538.75 |
| SFY-11A | South Fork Yaak River | -115.5799 | 48.8409 | 4547.34 |
| SFY-11B | South Fork Yaak River | -115.6384 | 48.7631 | 3921.30 |
| SFY-12A | South Fork Yaak River | -115.5673 | 48.8232 | 5237.62 |
| SFY-12B | South Fork Yaak River | -115.6410 | 48.7714 | 3882.53 |
| SFY-13A | South Fork Yaak River | -115.6130 | 48.8202 | 4221.00 |
| SFY-13B | South Fork Yaak River | -115.6410 | 48.7736 | 3868.06 |
| SFY-14A | South Fork Yaak River | -115.6212 | 48.8158 | 4066.20 |
| SFY-15A | South Fork Yaak River | -115.6121 | 48.7975 | 4036.13 |
| SFY-1AB | South Fork Yaak River | -115.6553 | 48.7610 | 3460.90 |
| SFY-2A | South Fork Yaak River | -115.7125 | 48.7622 | 4171.17 |
| SFY-2B | South Fork Yaak River | -115.6014 | 48.7258 | 4496.05 |
| SFY-3A | South Fork Yaak River | -115.7080 | 48.7587 | 4034.56 |
| SFY-3B | South Fork Yaak River | -115.6073 | 48.7378 | 4510.31 |
| SFY-4A-P | South Fork Yaak River | -115.7080 | 48.7587 | 4034.56 |
| SFY-4B | South Fork Yaak River | -115.6168 | 48.7405 | 4707.21 |
| SFY-5A | South Fork Yaak River | -115.6748 | 48.7625 | 3513.30 |
| SFY-5B | South Fork Yaak River | -115.6158 | 48.7330 | 4289.23 |
| SFY-6A | South Fork Yaak River | -115.6760 | 48.7522 | 3938.15 |
| SFY-6B | South Fork Yaak River | -115.6097 | 48.7328 | 4262.25 |
| SFY-7A | South Fork Yaak River | -115.6795 | 48.7481 | 3992.83 |
| SFY-7B | South Fork Yaak River | -115.6269 | 48.7311 | 3937.32 |
| SFY-8A | South Fork Yaak River | -115.6612 | 48.7510 | 3770.70 |
| SFY-8B | South Fork Yaak River | -115.6377 | 48.7290 | 3834.79 |
| SFY-9A | South Fork Yaak River | -115.6523 | 48.7473 | 3546.55 |
| SFY-9B | South Fork Yaak River | -115.6210 | 48.7641 | 4659.94 |
| LSC-1A | Lower Seventeenmile Creek | -115.7275 | 48.6398 | 3291.19 |
| SML-1B | Lower Seventeenmile Creek | -115.8511 | 48.6794 | 2652.57 |
| SML-2B | Lower Seventeenmile Creek | -115.7477 | 48.6454 | 3312.61 |
| SML-3B | Lower Seventeenmile Creek | -115.7491 | 48.6468 | 3265.97 |
| SML-4B | Lower Seventeenmile Creek | -115.7679 | 48.6598 | 2961.35 |
| SML-5B | Lower Seventeenmile Creek | -115.8153 | 48.6717 | 2944.64 |
| SML-6B | Lower Seventeenmile Creek | -115.8075 | 48.6670 | 3130.26 |
| USC-10A | Upper Seventeenmile Creek | -115.7378 | 48.5768 | 4673.81 |
| USC-11A | Upper Seventeenmile Creek | -115.7284 | 48.5515 | 5535.16 |
| USC-12A | Upper Seventeenmile Creek | -115.7586 | 48.5975 | 4390.28 |
| USC-13A | Upper Seventeenmile Creek | -115.7510 | 48.5968 | 4291.36 |
| USC-14A | Upper Seventeenmile Creek | -115.7539 | 48.5999 | 4277.85 |

**Table C-21. Field Assessment Site Location Data**

| LOCATION ID | HUC_6TH CODE | X | Y | Z |
|---|---|---|---|---|
| USC-15A | Upper Seventeenmile Creek | -115.7057 | 48.6092 | 3602.33 |
| USC-1A | Upper Seventeenmile Creek | -115.7157 | 48.6246 | 3379.28 |
| USC-2A-P | Upper Seventeenmile Creek | -115.7151 | 48.6238 | 3359.96 |
| USC-3A | Upper Seventeenmile Creek | -115.6634 | 48.6203 | 4181.79 |
| USC-4A | Upper Seventeenmile Creek | -115.6714 | 48.6183 | 4100.11 |
| USC-5A | Upper Seventeenmile Creek | -115.6824 | 48.6178 | 3838.58 |
| USC-6A | Upper Seventeenmile Creek | -115.6972 | 48.6236 | 3704.32 |
| USC-7A | Upper Seventeenmile Creek | -115.7136 | 48.5817 | 3988.61 |
| USC-8A | Upper Seventeenmile Creek | -115.7034 | 48.5718 | 4085.63 |
| USC-9A | Upper Seventeenmile Creek | -115.7248 | 48.5865 | 4491.59 |

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